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(54) **Endobronchial tube assembly**

(57) A twin lumen bronchial tube assembly with a bronchial tube (1) and a tracheal tube (10) has an inflatable cuff (2) that encircles the patient end (12) of the bronchial tube in the region of the right upper lobe (32). the bronchial cuff (2), when inflated, is of generally pear shape and circular section, having a channel-shape recess (24) extending from the patient end of the cuff rearwardly by about two thirds of its length. The recess (24) is formed by adhering a longitudinal strip of the cuff (2) to the outer surface of the tube. The bronchial cuff (2) seals the bronchus (31) above the upper lobe (32) and a tracheal cuff (40), encircling both tubes (1 and 10), seals the trachea (30) so that gas supplied to the tubes is supplied to respective bronchi (31 and 34). The recess (24) in the bronchial cuff (2) ensures that gas is supplied to the right upper lobe (32).

Fig.1.

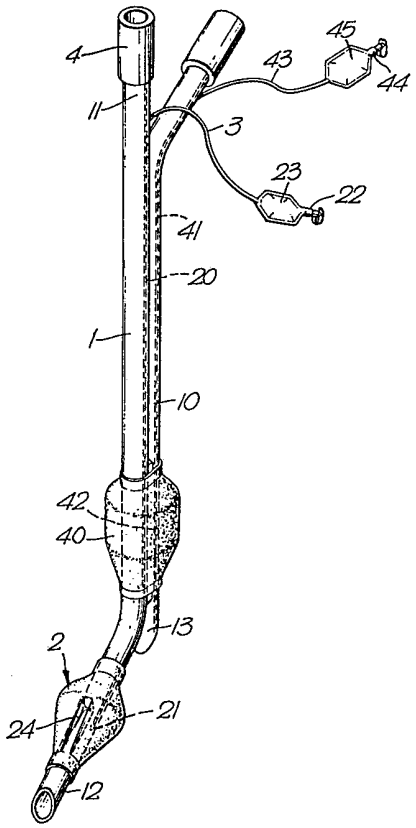

Fig.5.

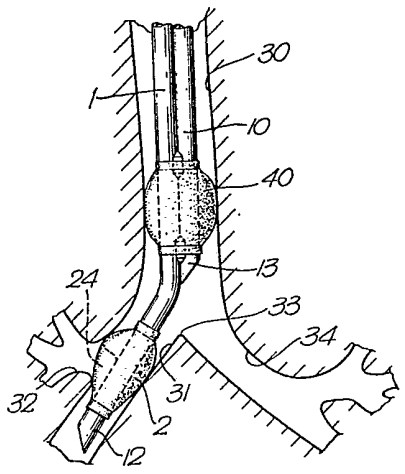

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Fig.1.

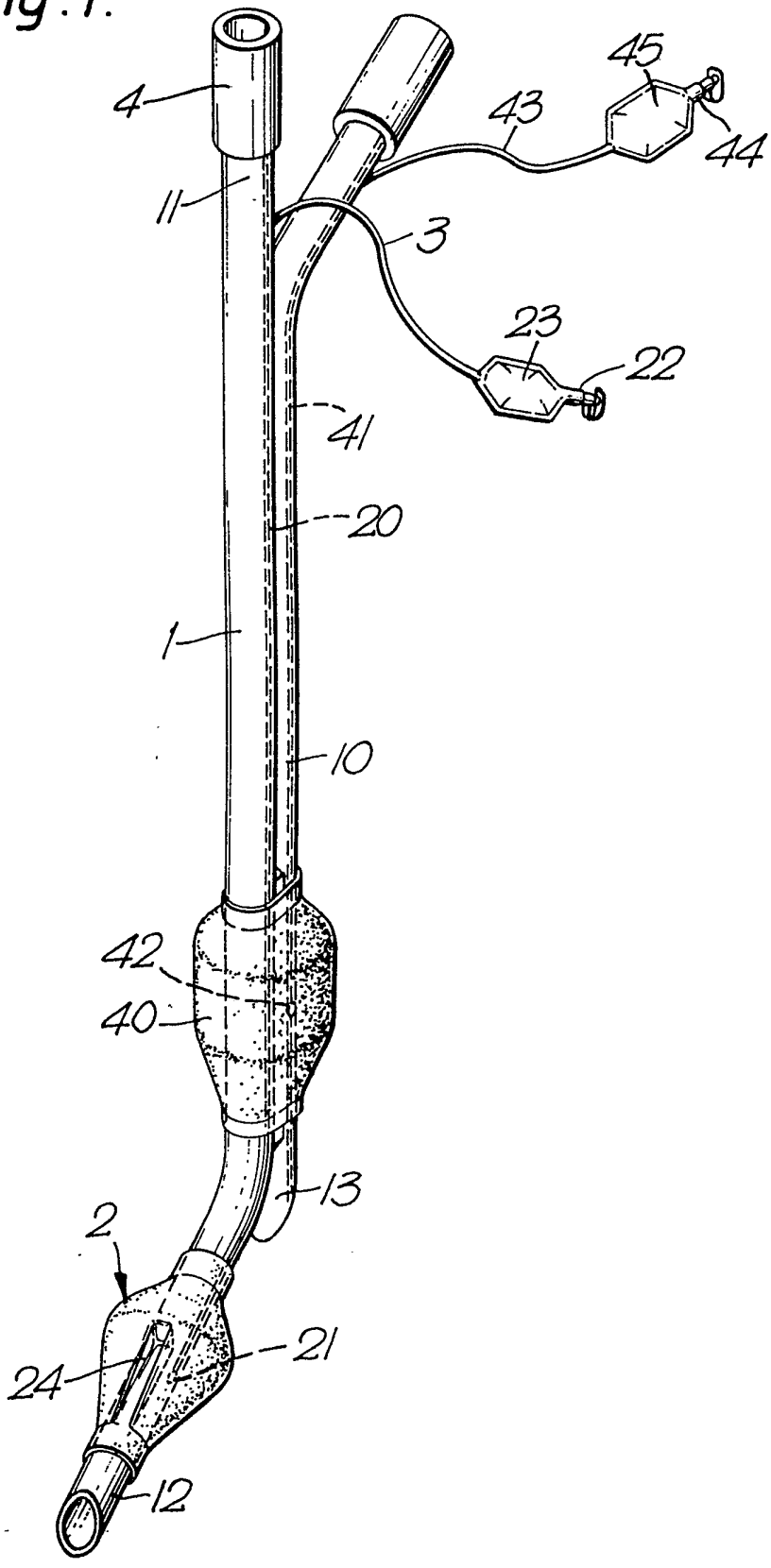

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Fig.2.

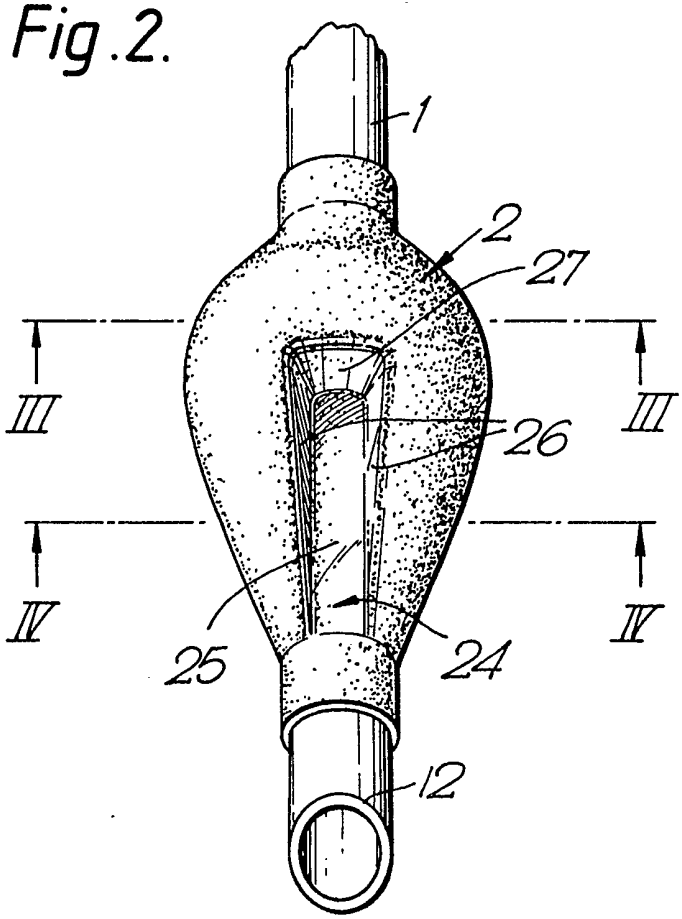


Fig.3.

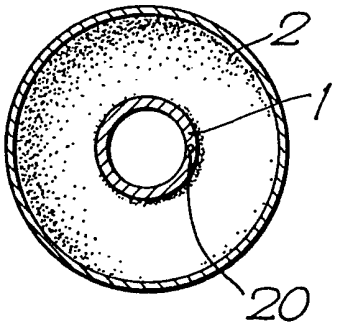


Fig.4.

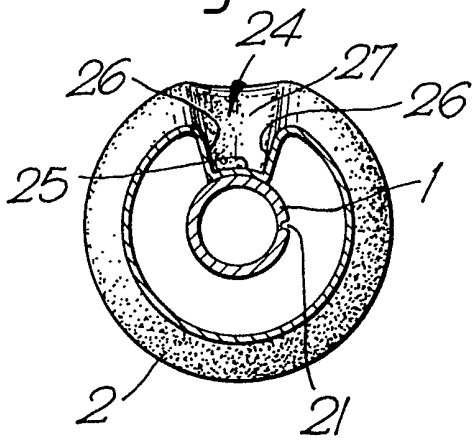


Fig.5.

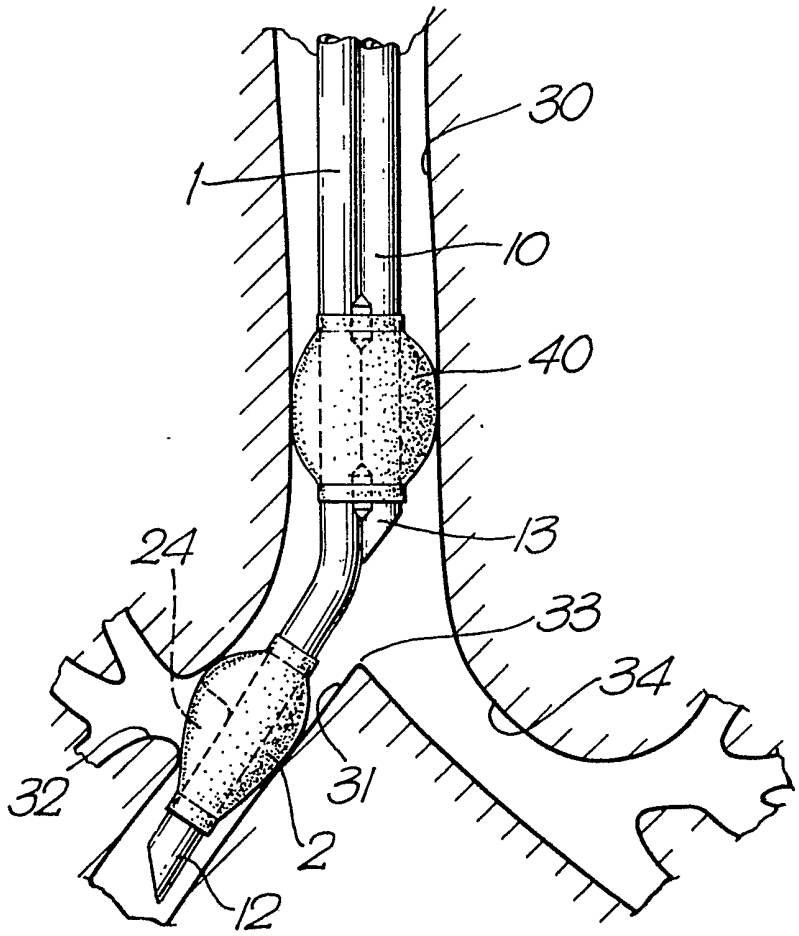
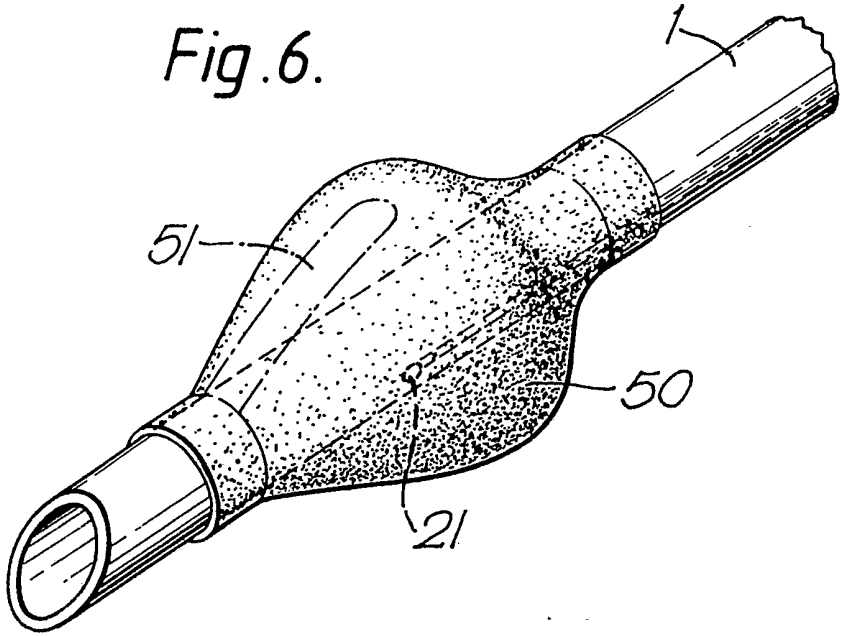


Fig.6.



SPECIFICATION

Bronchial tube assemblies

This invention relates to bronchial tube assemblies and to their manufacture.

The invention is more particularly related to endobronchial tubes for use in individual lung anaesthesia.

Various tube assemblies have been proposed for individual anaesthesia. In one arrangement, proposed by Gale and Waters in 1931, a tube with a single cuff is inserted into the right bronchus, the cuff being inflated just above the carina so that it blocks the right bronchus. This has the disadvantage that the cuff can also block the left bronchus and thereby prevent the left lung from collapsing. If the tube is inserted further into the bronchus there is the danger that the cuff will occlude the upper lobe of the right bronchus. In 1936, Magill proposed a tube assembly having a separate blocker, the tube is positioned so that it opens above the carina and is sealed with the trachea by a cuff. the blocker is in the form of a narrow tube with an inflatable cuff that is inserted through the main tube into the left bronchus, the cuff being inflated to seal the left bronchus from the right bronchus whilst the bore through the narrow tube enables the left lung to be separately vented. This arrangement has the disadvantage that the blocker cannot be used if there is an obstruction high in the left bronchus.

Another endobronchial tube assembly has been proposed by Green and Gordon (Anaesthesia Vol.12,No.1, January 1957). This assembly has a tube with two cuffs, the patient end of the tube being located just below the upper lobe in the right bronchus. One cuff, of standard shape, provides a seal with the trachea above the carina whilst the other cuff forms a seal with the right bronchus in the region of the upper lobe, so as to seal the right bronchus from the left bronchus. The latter cuff is shaped so that it is of circular section at its machine end and semicircular in section over the rest of its length. The circular section is located above the upper lobe to seal the right bronchus, whilst the semicircular part of the cuff contacts only that part of the bronchial wall opposite the upper lobe. With such an arrangement, the semicircular shape of the patient end of the cuff displaces the tip of the tube to that side of the bronchus opposite the cuff. This can cause the tip of the tube to contact the bronchus with consequent possible abrasion and an increased localised drying of the bronchial wall caused by the emerging gases. Because the tip of the tube is forced to one side of the bronchus there tends to be only a small gas path between the tube tip and upper lobe. This requires the provision of a separate lateral opening in the tube wall in the region of the upper lobe if adequate ventilation of the upper lobe is to be ensured.

It is an object of the present invention to provide an improved bronchial tube assembly that alleviates the above-mentioned problems, and a method of manufacture of such an assembly.

According to one aspect of the present invention there is provided a bronchial tube assembly comprising: a bronchial tube having a machine end adapted for connection to a supply of gas and a patient end for location within a bronchus, the patient end being arranged to open into the bronchus below the upper lobe; and an inflatable cuff encircling the tube in the region of the upper lobe, the cuff being of generally circular section and having a channel-shape recess therein extending longitudinally from the patient end of the cuff rearwardly along a part only of the length of the cuff such that the cuff when inflated seals the bronchus above the upper lobe and such that the recess enables access of gas between the patient end of the tube and the upper lobe.

The shape of the cuff and the recess ensures that the tube is maintained centrally within the bronchus and avoids the need for any lateral opening in the wall of the tube for supply of gas to the upper lobe.

The cuff preferably tapers to a smaller diameter at its patient end such that the cuff has a generally pear shape. The recess may be of generally rectangular section and may extend along approximately two thirds of the length of the cuff. The width of the recess is preferably less than the diameter of the the tube and may be about half the diameter of the tube. The assembly may include an inflation lumen that extends along the tube through its wall and opens into the interior of the cuff. Preferably the only path for supply of gas to the upper lobe is via the open patient end of the tube and the recess. The recess may be formed by adhering a longitudinal strip along the cuff to the tube. The assembly may include a tracheal tube that extends along the bronchial tube, the tracheal tube being arranged to open at its patient end above the cuff of the bronchial tube, and a second inflatable cuff encircling both the bronchial and tracheal tubes in the region of the trachea such that when the second cuff is inflated it seals with the trachea and gas supplied to the trachea tube flows into the other bronchus.

According to another aspect of the present invention there is provided a method of manufacture of a bronchial tube assembly including the steps of: providing a tube having a machine end for connection to a supply of gas, a patient end for location within a bronchus, the patient end opening into the bronchus below the upper lobe, and an inflation lumen that opens on the outer wall of the tube close to the patient end; locating a flexible sleeve of generally circular section on the tube over the opening of the inflation lumen; sealing the sleeve at both ends around its circumference to the outside of the tube to form an inflatable cuff on the tube; and adhering a longitudinal strip of the sleeve extending from the patient end along a part only of the length of the sleeve to the wall of the tube so as to form a channel-shape recess in the cuff that enables access of gas between the patient end of the tube and the upper lobe.

According to a further aspect of the invention there is provided a bronchial tube assembly manufactured according to the above other aspect of the present invention.

A twin lumen endobronchial tube assembly and a method of manufacture of such an assembly, in accordance with the present invention, will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a perspective view of the tube assembly;

Figure 2 is a side elevation view of the patient end of

a part of the assembly;

Figures 3 and 4 are transverse sectional views of the assembly along the lines III and IV respectively of Figure 2;

Figure 5 illustrates the assembly in use; and

Figure 6 shows the patient end of a part of the assembly at a preparatory stage in manufacture.

With reference first to Figures 1 to 4, the twin lumen endobronchial tube assembly comprises a bronchial tube 1 and a tracheal tube 10 that are joined together in a side-by-side relationship. Both tubes 1 and 10 are of flexible plastics material, such as PVC, and have an internal diameter of 7 mm and an external diameter of 8.5 mm. the bronchial tube 1 is 430 mm long while the tracheal tube 10 is shorter, being 370 mm long and opening 6[illegible]mm above the patient end 12 of the bronchial tube. These dimensions may vary for patients of different builds, and for children.

In its natural state, the bronchial tube 1 is straight from its machine end 11 to a point about 70 mm from its patient end 12, where it is bent at an angle of about 20 degrees away from the tracheal tube 10. The patient end 12 of the bronchial tube is angled and smoothly rounded to reduce trauma, whilst the machine end 11 is provided with a coupling 4 for connection to an anaesthetic gas source or ventilator in the usual way. A small bore lumen 20 extends along the length of the bronchial tube within its wall. The lumen 20 is closed at the patient and machine ends of the bronchial tube but opens, through an opening 21 cut in the outer wall of the tube, into the interior of a bronchial cuff 2. One end of an inflation line 3 is connected with the lumen 20 close to the machine end of the tube, the other end of the inflation line being provided with a conventional coupling 22 and inflation indictor 23.

The bronchial cuff 2 is located close to the patient end 12 of the bronchial tube 1 and, when inflated at low pressure, is of generally pear shape, tapering to a reduced diameter towards its patient end. Typically, the cuff 2 is about 30 mm long, as can be seen in Figure 3, is of circular section at its machine end having a maximum diameter of about 25 mm. With reference particularly to Figure 4, the cuff 2 has a channel-shape recess 24 of generally rectangular section that extends longitudinally from the patient end along about two thirds of the length of the cuff. The shape of the recess 24 is defined by a substantially flat or convex floor 25 formed by a longitudinal strip along the tube 1 to which a part of the cuff material is adhered, and by inclined side walls 26 and an end wall 27. The width of the recess 24 is less than the diameter of the tube 1 and, in particular, is about half its diameter. In general, any channel shape recess may be used, that is, any recess with side walls inclined to its floor, so that the patient end of the cuff acts to space the tube 1 away from the bronchial wall on all sides.

The tracheal tube 10 is straight in its natural state, and its patient end 13 is cut at an angle inclined away from the bronchial tube, being smoothly rounded to reduce trauma. A tracheal cuff 40 encircles both tubes 1 and 10 just to the rear of the patient end 13 of the tracheal tube 10. A small bore lumen 41 extends along the length of the tracheal tube 10 within its wall. the lumen 41 is closed at the patient and machine ends of the tracheal tube but opens through an opening 42 cut in the outer wall of the tube, into the interior of the tracheal cuff 40. One end of an inflation line 43 is connected with the lumen 41 close to the machine end of the tube, the other end of the inflation line being provided with a conventional coupling 44 and inflation indicator 45.

The tracheal cuff 40 is a conventional low pressure cuff the size of which is selected to seal, when inflated, with the surface of the patient's trachea. In the region where the ends of the cuff 40 are joined to the assembly, a smooth convex surface is formed around the assembly such as by filling the valley between the tracheal tube 10 and the bronchial tube 1 with a plastics cement.

The use of the endobronchial tube assembly will now be described with reference to Figure 5. The assembly is inserted, with both cuffs 2 and 40 deflated, through the patient's mouth (not shown) and trachea 39 until the patient end 12 of the bronchial tube 10 enters the right bronchus 31, and extends just below the upper lobe 32, with the patient end 13 of the tracheal tube 10 lying just above the carina 33 in the trachea 30. The bend in the bronchial tube 1 is selected so that the tube follows the line of the trachea 30 and right bronchus 32. A stylet may be used to maintain the bronchial tube straight during insertion. When correctly inserted, the bronchial cuff 2 lies level with the upper lobe 32, extending above and below it along the bronchus 31. A radio-opaque marker may be included in the assembly to facilitate correct positioning. The cuffs 2 and 40 are then inflated by pumping a predetermined volume of gas into them via the inflation lines 3 and 43 and lumens 20 and 41 respectively. In this way, the machine end of the bronchial cuff 2 seals the right bronchus 31 in a region just above the upper lobe 32 and extends below the upper lobe. The bronchial cuff 2 is oriented so that the recess 24 is on the inside of the bend in the tube 1 and so that the recess lies adjacent the upper lobe 32. the tracheal cuff 40 seals the trachea 30 above the carina 33.

Ventilation is then carried out by administering gas to the tubes 1 and 10 at their machine ends in the usual way. Gas supplied to the tracheal tube 10 emerges from its patient end 13 into the trachea 30. Because passage of gas from the trachea 30 to the right bronchus 31 is blocked by the bronchial cuff 2, all the gas supplied to the tracheal tube passes into the left bronchus 34. Gas supplied to the bronchial tube 1 emerges from its patient end 12 into the right bronchus 31 and is free to flow into the upper lobe 32 via the recess 24.

The shape of the bronchial cuff 2 is therby effective to seal the right bronchus 31 without the risk of sealing the left bronchus, whilst the recess 24 allows ventilation of the upper lobe 32 without the need for any additional opening through the wall of the tube. The shape of the cuff 2 also maintains the patient end 12 of the tube 1 centrally in the bronchus 31 thereby reducing the risk of damage to the lining of the bronchus.

With reference now to Figure 6, the cuff 2 on the bronchial tube 1 may be made by placing a flexible plastics sleeve 50 of pear shape on the tube 1, to

overlie the inflation lumen opening 21, and then sealing the sleeve about its circumference at both ends, such as by means of a solvent or by heat welding. The channel-shape recess 24 is then formed by adhering a longitudinal strip 51 of the sleeve 50 to the outside of the tube 1 so that it forms the floor 25 of the recess and so that adjacent regions of the sleeve form the walls 26 and 27 of the recess. The strip 51 could be adhered to the tube by means of a solvent or adhesive on the outside of the tube or on the inside of the sleeve, or by a heat welding technique. Although it will be appreciated that the recess 24 could be provided by means of a preformed sleeve, the method described above makes it possible to use a sleeve of conventional shape and thereby avoids the need for moulding a cuff of special shape.

The bronchial cuff need not be pear shape but could, for example, be more cylindrical or spherical in shape, if desired. The bronchial cuff could be used on other bronchial tubes, such as those having only one lumen.

CLAIMS

1. A bronchial tube assembly comprising: a bronchial tube having a machine end adapted for connection to a supply of gas and a patient end for location within a bronchus, the patient end being arranged to open into the bronchus below the upper lobe; and an inflatable cuff encircling the tube in the region of the upper lobe, wherein the cuff is of generally circular section and has a channel-shape recess therein extending longitudinally from the patient end of the cuff rearwardly along a part only of the length of the cuff such that the cuff when inflated seals the bronchus above the upper lobe and such that the recess enables access of gas between the patient end of the tube and the upper lobe.

2. A bronchial tube assembly according to Claim 1, wherein the cuff tapers to a smaller diameter at its patient end such that the cuff has a generally pear shape.

3. A bronchial tube assembly according to Claim 1 or 2, wherein the recess is of generally reactangular section.

4. A bronchial tube assembly according to any one of the preceding claims, wherein the recess extends along approximately two thirds of the length of the cuff.

5. A bronchial tube assembly according to any of the preceding claims, wherein the width of said recess is less than the diameter of the said bronchial tube.

6. A bronchial tube assembly according to Claim 5, wherein the width of the said recess is about half the diameter of the said bronchial tube.

7. A bronchial tube assembly according to any one of the preceding claims, wherein the assembly includes an inflation lumen that extends along the tube through its wall and opens into the interior of the cuff.

8. A bronchial tube assembly according to any one of the preceding claims, wherein the only path for supply of gas to the upper lobe is via the open patient end of the tube and the said recess.

9. A bronchial tube assembly according to any one of the preceding claims, wherein the said recess is formed by adhering a longitudinal strip along the cuff to the tube.

10. A bronchial tube assembly according to any one of the preceding claims including a tracheal tube that extends along the said bronchial tube, said tracheal tube being arranged to open at its patient end above the cuff of the bronchial tube, and a second inflatable cuff encircling both the bronchial and tracheal tubes in the region of the trachea such that when the second cuff is inflated it seals with the trachea and gas supplied to the tube flows into the other bronchus.

11. A bronchial tube assembly including a cuff substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

12. A bronchial tube assembly substantially as hereinbefore described with reference to Figures 1 to 5 of the accompanying drawings.

13. A method of manufacture of a bronchial tube assembly including the steps of: providing a tube having s machine end for connection to a supply of gas, a patient end for location within a bronchus, the patient end opening into the bronchus below the upper lobe, and an inflation lumen that opens on the outer wall of the tube close to the patient end; locating a flexible sleeve of generally circular section on the tube over the opening of the inflation lumen; sealing the sleeve at both ends around its circumference to the outside of the tube to form an inflatable cuff on the tube; and adhering a longitudinal strip of the sleeve extending from the patient end along a part only of the length of the sleeve to the wall of the tube so as to form a channel-shape recess in the cuff that enables access of gas between the patient end of the tube and the upper lobe.

14. A method of manufacture of a bronchial tube substantially as hereinbefore described with reference to the accompanying drawings.

15. A bronchial tube assembly made by a method according to Claim 13 or 14.

16. Any novel feature or combination of features as hereinbefore described.

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